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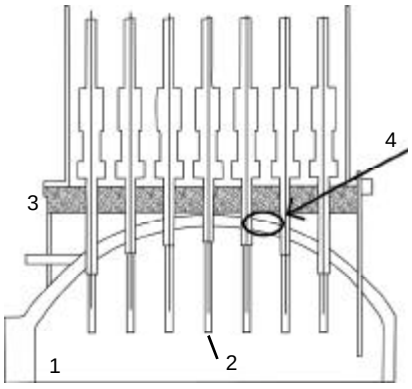
MILLIMETERS FROM DISASTER

A hole of almost unbelievable proportions was recently found at the Davis-Besse Nuclear Power Station in the U.S. state of Ohio. Boric acid from a cracked control rod nozzle had eaten almost right through the lid of the reactor vessel. The incident has implications for reactors all over the world, though up until now, few national nuclear safety authorities seem to be acting on the issue.

(565.5385) NIRS/WISE Amsterdam – The story seems almost unbelievable. Boric acid had eaten a hole right through the 6-inch (15 cm) thick lid of the reactor vessel, leaving only a 3/16 inch (less than 5mm) stainless steel liner intact. The pressure had caused this liner to bulge out, almost blowing a hole in the reactor lid. Not only that, but according to information from the U.S. Nuclear Regulatory Commission (NRC), the hole was only discovered because of a bizarre incident which happened while repairs were being carried out on the reactor.

Repairs were being carried out on the control rod nozzles – the sleeve-like joints where the control rods, which regulate the reactor's power, enter the reactor vessel. These nozzles are susceptible to cracking, particularly at the point at which they are welded to the reactor vessel lid. The problem was first noticed in Bugey-3 in France in 1991 (see *WISE News Communique* 385.3770, "Alarm over faulty design in European PWRs").

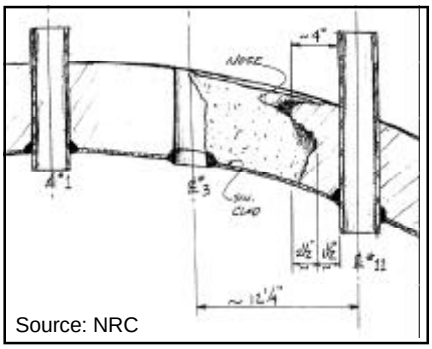


1. reactor vessel head
2. control rod
3. insulation
4. damaged area (see other diagram)

Most countries replaced the vessel heads of all affected reactors.

However, the U.S. nuclear industry has spent years doing its utmost to delay tackling the problem (see *WISE News Communique* 553.5309, "US: NRC ignores widespread safety flaw for decade"). Finally, in August 2001, the NRC sent out a request to PWR operators, asking them to tackle the problem by 31 December 2001.

The NRC had ranked Davis-Besse as one of the plants most susceptible to nozzle cracking, which was first found at Oconee-3. Nevertheless, plant operator First Energy kept pressing for a time extension to the 31 December deadline. After initially threatening to order a shutdown, the NRC backed down and allowed the plant to continue operation. Finally, inspections took place during Davis-Besse's refueling outage, which began on 16 February. Five of the 69 control rod nozzles were found to have cracks, and the maintenance team began to repair them.


Source: NRC

Bizarre incident

At this point, the incident occurred which led to the discovery of the

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hole. A machine used to repair the nozzles was prematurely moved, bending one of the nozzles so much that it touched another nozzle. While investigating this, maintenance workers noticed then noticed that the nozzle had fallen into a hole 4 inches by at least 5 inches across (10 by 12.5 cm). Most alarming was that the hole was 6 inches (15 cm) deep, and ran right through the reactor head, down to the stainless steel lining, which is resistant to boric acid corrosion.

Just 3/16 inch (less than 5 mm) of this liner separated the reactor's highly radioactive and pressurized internal environment (150 times atmospheric pressure) from blasting into the reactor containment building, damaging safety equipment and possibly setting into motion a core melt accident. What is more, the liner had bulged out about 1/8 inch (3mm), illustrating how close the reactor came to bursting.

The boric acid deposits on the reactor were far from new – the NRC had known since 1998 that boric acid had accumulated in the area where the hole was found. However, not all boric acid was cleaned off the vessel, apparently because this would have led to high radiation doses for workers. As a result, corrosion of the reactor pressure vessel – the most fundamental component of a nuclear reactor – was allowed to continue unchecked.

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Another reason that the hole was not noticed is that the top of the reactor was covered in metallic insulation. This is also common for other reactors, as Mary Olson of NIRS' Southeast office in Asheville, North Carolina, pointed out. "While other reactor operators looked for cracked nozzles, they did not necessarily look for corrosion on the reactor vessel, and might not be able to because of insulation or shielding around the very area where the leaks might be pooling." Where insulation or shielding is present, Olson conjectured, it "would not prevent this pooling, and might even exacerbate it."

The reactor coolant at Davis-Besse as at other nuclear reactors is a solution of boric acid in water. Reactor coolant escaping through cracks and around flanges on the control rod drive mechanisms allows the corrosive boric acid to drip, crystallize and attack the carbon steel exterior surface.

While the corrosion apparently stopped at the stainless steel liner, given a wide enough cavity in the carbon steel, the reactor pressure vessel could have ruptured as the result of the extreme internal pressure exceeding the shear stress of the steel liner. This would then tear a hole through the vessel wall from the inside out and releasing a high-pressure jet stream of radioactive water much like a super fire hose. This in turn could damage reactor safety equipment located directly above the reactor vessel and potentially introduce a shock wave sufficient to break already cracked control rods ejecting them as missiles further damaging equipment including other control rods needed to shut down the reactor.

"First Energy pushed this reactor beyond all reasonable safety margins and the NRC basically allowed it," said Paul Gunter, Director of the NIRS Reactor Watchdog Project. "This was a dangerous nuclear experiment on public safety that came damn close to exceeding the strength of a fundamental piece of reactor safety equipment, the reactor pressure vessel," he said.

"Davis-Besse is a highly susceptible reactor with known deteriorating margins of reactor safety in this area," said NIRS staffer Kevin Kamps. "First Energy operators calculated the risks of running the reactor to their scheduled February outage to maximize their profits," said Kamps. "Such high-stakes risk taking means gambling with the health and safety of very large numbers of people," Kamps concluded.

The new incident seems finally to have stung the NRC into action. A new project manager, Steven Bloom, has been appointed to deal with the issue of reactor vessel head corrosion. The NRC have asked industry lobby group Nuclear Energy Institute (NEI) to carry out a survey of utilities that might be affected by the problem. The NEI presented the initial results to a meeting on 19 March. The NRC held a further public meeting on 20 March.

Second – and maybe third – hole

At the meeting, more details came to light. Further investigation had revealed two cavities, smaller than

DAVIS-BESSE AND TMI

The Davis-Besse reactor was built to a Babcock and Wilcox design very similar to the Three Mile Island (TMI) reactors, and shares similar problems. Eighteen months before the 1979 partial meltdown at TMI-2, there was a similar accident at Davis-Besse in which a relief valve failed to close. However, no serious damage was done because the plant was only operating at 9% power at the time, compared to 97% at TMI-2. Unbelievably, in the summer of 1985 it happened again – this time the relief valve was shut after a minute (compared to two hours in the TMI-2 accident).
***SCRAM Energy Bulletin*, February/March 1981; *SCRAM Journal*, August/September 1985**

the first, near another nozzle – one on the outside and one further in. It was not known whether these cavities were joined together, i.e. whether they formed one big hole or two separate, smaller ones.

As well as the possibility that pools of leaking reactor coolant caused the corrosion, there is now a second theory. A high-pressure jet of leaking reactor coolant could have bored the holes in the reactor. If this "boring" theory is true, then reactors with leaking control rod nozzles could have cavities inside the steel of their reactor lids, which would not be discovered by visually inspecting the surface of the lids – as operators of other reactors are planning to do.

The NRC has given operators of the other 68 U.S. PWRs the unusually short time of two weeks to provide further information, including when and how they inspect the reactor vessel head, to prove that they continue to meet regulatory requirements.

Other countries

Reactors in other countries that have experienced control rod nozzle cracking include Sendai-1 in Japan (see *WISE News Communique* 461.4583, "Japan: Radioactive water leak in Sendai-1"). Similar cracking was found at José Cabrera (also known as Zorita), Spain's oldest operating nuclear power station (see *WISE News Communique* 408.4043, "New cracks found at Zorita NPP"). Amongst other reactors known for nozzle cracking problems are Beznau 1 and 2 in Swizerland, which also have other problems such as lack of protection against aircraft crashes (see *WISE News Communique* 415/6.4116, "Beznau: Safety deficiencies"). WISE Amsterdam faxed details of the Davis-Besse incident to all of these nuclear power stations, but has not received any responses.

Despite this, nuclear safety authorities outside the U.S. seem to have been slow to react. Since the problem is by no means confined to U.S. reactors, we suggest that readers outside the U.S. contact their local nuclear safety authority to ask them what steps they are taking to make sure that boric acid is not busy eating holes in their reactors too.

Sources*: Nucleonics Wee*k, 14 March 2002; NIRS press release, 13 March 2002; Web site www.nrc.gov; *Toledo Blade*, 5 December 2001; Email from Dave Lochbaum, Union of Concerned Scientists, 19 March 2002

Contact: Paul Gunter or Kevin Kamps at NIRS in Washingrton, D.C. or Mary Olson, NIRS Southeast.

NUCLEAR EXCLUDED FROM EU ENVIRONMENTAL LIABILITY DIRECTIVE

On 23rd January 2002, the European Commission presented its "Proposal for a Directive on Environmental Liability with regard to the prevention and restoration of environmental damage". The proposal is very disappointing in general terms. But of course nuclear power as the Commission's favorite is the big exception: It is completely excluded.

(565.5386) Friends of the Earth Europe - It is important to know that the directive does not cover the "environment", but only biodiversity, which is only sites and species under the EU's Habitats Directive and Birds Directive or national legislation – the directive will only apply to about 13% of the EU's territory!

The Commission's argument for excluding nuclear is that nuclear damage is already covered by other international conventions. The Commission claims that these conventions foresee a "very strict liability regime and do not cover only traditional damage, but also environmental damage [and] …almost all Member States (13 out of 15) are signatories to the Paris Convention".

It is true that there are several international conventions, but they do not serve the purpose of making operators of nuclear facilities liable for damage. Instead, they protect the operators from paying compensation. They do not cover environmental damage. And only 12 out of 15 EU states are signatories to the Paris Convention – Austria, Ireland and Luxembourg are not. This shows that the nuclear liability question within the EU is not solved.

On 4 March the EU environmental ministers discussed this proposal. Ireland, Luxembourg and Austria demanded that nuclear be included. But they will not be able to succeed unless we support this effort. Antinuclear activists should see what an enormous chance this is, because no insurance will cover the nuclear industry! Friends of the Earth Europe (FoEE) is planning a coordinated effort to lobby environmental ministers and the European Parliament, but we need your help! A factsheet can be ordered from FoEE.

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CAMPAIGN TO CLOSE INDIAN POINT

An incredible amount of organizing is under way to try to get Indian Point shut down. The U.S. nuclear power station, with two operating reactors plus a third which was closed in 1974, is just 40 miles (60 km) from the center of New York City. Even "soccer moms" – frantic mothers more usually seen at school sports events – have got involved, and once they get involved, there's no turning back…

(565.5387) Hudson Riverkeeper/ Clearwater - With 21 million people living within a 50-mile radius of Indian Point's two nuclear reactors on the Hudson River (just south of Peekskill, in the town of Buchanan), a terrorist attack on the plants could have devastating consequences. For that reason Riverkeeper, Clearwater, Sierra Club and a broad coalition of nearly 40 environmental and civic groups and elected officials petitioned the Nuclear Regulatory Commission to suspend the operating licenses of both reactor units 2 and 3. The coalition has also urged Governor Pataki to offer greater leadership in addressing the inadequacies associated with the emergency evacuation plan.

Riverkeeper, Clearwater, Citizens Awareness Network and other organizations were flooded with phone calls from residents across the region. Had anyone studied the vulnerability of Indian Point to terrorist attack? What kinds of security measures were in place to protect us from such an event? What would happen if fuel-laden jetliners crashed into the twin domes or the irradiated spent fuel pools of the Indian Point reactors? How far would a radioactive release travel in the event of an attack?

Couldn't something be done to shut down Indian Point or at least force its owners to improve security to safeguard the millions of people living within its shadow? So began our campaign.

Given its proximity to the greater New York metropolitan area, and the severe consequences for New York City in the event of a successful terrorist attack on the plant, we believe Indian Point is a special case that deserves special attention. The terrorist threat to nuclear facilities was highlighted by recent statements made by President George Bush (see *WISE/NIRS Nuclear Monitor* 562, "In Brief"), Department of Defense Secretary Donald Rumsfeld, and Department of Energy Secretary Spencer Abraham.

On 8 November, Riverkeeper and a coalition of public interest groups and local, state and federal elected officials petitioned the Nuclear Regulatory Commission (NRC) to order an immediate shutdown of Indian Point Units 2 and 3 – at least until the NRC can clearly demonstrate that the plants can be operated safely. Reasonably, you might wonder what difference a temporary shutdown would make.

According to scientists at the Nuclear Control Institute (NCI) and Union of Concerned Scientists, within days of shutting down the reactors, the possibility of a full meltdown is greatly reduced, thus reducing the number of prompt fatalities and long-term cancer deaths that would result from an attack on the containment domes. Furthermore, according to a preliminary analysis conducted by NCI, after a shutdown of twenty days – which would greatly reduce the radioactive inventory in the core through decay – the number of acute fatalities (within a 10-mile radius) from a core meltdown and breach of containment could be reduced by 80% and the number of long-term cancer deaths (within a 50-mile radius) by 50%.

A shutdown of the reactors would not only allow Entergy, the plant's owner, to focus its defenses on a more limited number of targets, but it would provide the necessary financial and political incentives for the operator and the NRC to take steps to address the plant's vulnerabilities.

This campaign is perhaps the most challenging that Riverkeeper, Clearwater, and Citizens Awareness Network has ever taken on. Efforts to shut down the nuclear reactors in Buchanan date back more than two decades. Now, with the eyes of the nation on New York, the nuclear industry will undoubtedly mobilize its resources and political clout in an effort to stop us. But with the terrible events of 11 September, the world – and how we view it – has changed. And so must our response.

And we are not alone. In mid-December, a new broad-based coalition of about 20 local, regional and national environmental and citizens groups banded together to form the Indian Point Safe Energy Coalition (IPSEC). The coalition has now grown to nearly 40 organizations.

Formed in response to a flood of citizen concern about the safety of the Indian Point nuclear power plant

WORST U.S. REACTOR

Indian Point 2 was given the lowest performance rating of all 103 U.S. power reactors in the NRC's annual review. It was the only reactor to reach the second-lowest of five categories – a position it has held for more than a year. In the year ended 30 September 2001, the NRC spent more than twice as many hours monitoring Indian Point 2 as they spent on any other reactor. Nevertheless, in October 2001, four of the plant's seven reactor control room crews failed their annual re-qualification tests.
Newsday, 8 March 2002; www.riverkeeper.org

following the 11 September terrorist attacks, IPSEC incorporates many community-based organizations of concerned residents and parents such as the Citizens Awareness Network, Citizens United for Safe Energy and Fishkill Ridge Caretakers; regional environmental groups such as Sierra Club's Atlantic Chapter, and New York Public Interest Group (NYPIRG); New York City groups such as Communities United for Responsible Energy and NYC Women's Action for New Directions; specialized expert groups such as the Pace Energy Project and NIRS; and national groups such as Friends of the Earth, Public Citizen, Greenpeace and many more.

In light of the 9-11 events, these groups are united in calling for immediate shutdown of Indian Point, securing of the irradiated "spent" fuel rods stored on site, an independent review of the safety of any future plant operations, and in opposing certification of what they say is an ineffective and unworkable evacuation plan. They also call for making evacuation plan documents widely available for residents to read, after the NRC removed them from their website and public documents room recently, citing security concerns.

The threat of an assault on Indian Point and the correct belief that the emergency evacuation plan is inadequate have added public pressure to shut the facility. In a 3 February 2002 editorial for the *Journal News*, reporter Phil Reisman writes, "With all the talk about potassium iodide supplies and the logistical nightmare of transporting children in school buses on clogged county roads, Indian Point has in the space of only a few months become a full-blown 'soccer mom' issue."

Elected officials are responding to the growing outcry. Congresswoman Sue Kelly and Westchester County Executive Andy Spano returned contributions made by Enpac-New York, the fund-raising arm of Entergy. Spano said he decided to return the money to clear up any perception that he was influenced by the donation by Enpac-New York. "There was no reason not to accept it, and for that same reason, there is no reason I need to have it," Spano said. "There is no reason we need it and no reason to give this sort of perception."

On 6 February 2002, County Executive Andy Spano announced that Westchester County has gone on-line with a new website to solicit comments from the public on the county's Radiological Emergency Preparedness Plan. "I would prefer that Indian Point be closed," said Spano. "But the fact of the matter is, the plant is here, and no matter what anyone says it's not going to close tomorrow. That being said, we need to have a workable response plan, and we need everyone's help to develop the best possible plan. Since I took office, we've continually updated this plan, but now in the wake of Sept. 11 we need to take another look. We continue to meet with school superintendents, police, fire, hospital, transportation and municipal officials and other experts. This new website is just one more thing we are doing to get public input.'' The website is at www.westchestergov.com/discemergplan

For more information and to learn how you can help the campaign visit www.riverkeeper.org; www.closeindianpoint.org; and www.clearwater.org.

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IMPACTS OF A CATASTROPHIC RELEASE

HEALTH EFFECTS:

· Radiation is a health hazard because it can damage or destroy cells within the human body. Damaged cells can induce cancers years later or pass the damage along to future generations. Dead cells can trigger infections or incapacitate organ functions.

· "Calculation of Reactor Accident Consequences" ("CRAC-2") data, from a 1982 study performed by Sandia Labs for the NRC, estimates that a meltdown at the Indian Point Unit 2 reactor would cause "46,000 Peak Early Fatalities, 141,000 Peak Early Injuries, [and] 13,000 Peak Deaths from cancer." A meltdown of the Indian Point Unit 3 reactors would cause "50,000 Peak Early Fatalities, 167,000 Peak Early Injuries, [and] 14,000 Peak Deaths from cancer."

-This data assumes a "successful" evacuation.

-These are conservative estimates since population has since increased within the 17.5-mile radius peak fatality zone and the 50-mile radius peak injury zone.

-CRAC-2 data refers to first year impacts

ECONOMIC IMPACTS:

· In addition, the CRAC-2 Report reveals that a catastrophic release of radiation from Indian Point Unit 2 or 3 reactors would cause US$274 billion (1982 dollars) in property damage, and US$314 billion (1982 dollars) in property damage respectively.

· In terms of 2000 dollars, property damage from a Unit 2 meltdown would be estimated conservatively at US$500.5 billion, and property damage from a Unit 3 meltdown would be estimated conservatively at US$573.5 billion — figures based solely on inflation without factoring the substantial rise in metropolitan area real estate values.

· Data from the New York State Office of Real Property Services show that property values in Westchester County, and NY State in general, have increased four-fold since 1982. Adjusted for inflation and a quadrupling of real estate prices since 1982, the figure for Westchester County property damages is probably closer to US$2.3 trillion, in 2000 dollars.

· Including the effect on New York City and other surrounding counties would result in a figure in the tens of trillions of dollars in economic losses.

· Homeowners insurance policies do **not** cover losses caused directly or indirectly by nuclear hazards. The Price-Anderson Act, enacted in 1957 and now up for renewal, limits the industry's financial liability for accidents, either in a reactor or research facility, in storage, or in transit.

SECURING THE ENERGY FUTURE OF THE UNITED STATES

The U.S. is at a crossroads in energy and security policy. The attacks of September 11, 2001 have revealed, as nothing has done before, the vulnerability of the U.S. energy system to a variety of disruptions. The Bush administration's proposed energy plan – released in May 2001 and neither reviewed nor changed in light of the events of September 11 – would worsen these vulnerabilities. In this article, the Institute for Energy and Environmental Research (IEER) describes their alternative to the Bush energy plan.

(565.5388) IEER - In November 2001, IEER released a preliminary report presenting a plan for a more secure energy future for the United States. The report is part of IEER's energy project, which we began about two years ago to examine the feasibility and time span required for a complete phase-out of nuclear power and a substantial (on the order of 50 percent) reduction in carbon dioxide emissions worldwide. We released it

Table 1: Vulnerabilities of the oil and nuclear elements of the energy system

Energy system element	Type of vulnerability	Worst case consequences	Comments
Oil Imports	Political, wartime, or terrorist disruption of Persian Gulf oil (see note)	Depends on long-term level of oil imports and nature of disruption. Severe and prolonged global economic disruption and possibly expanded war in the Persian Gulf region are possible.	Nuclear consequences possible in case of large-scale political and military instability in the region. Several nuclear-armed states involved in the region.
Light Water Reactor	Only to massive attack	Catastrophic radioactivity releases, comparable to Chernobyl. Massive, long-term economic losses and environmental damage.	Secondary containment designed to contain all but the worst attacks
Spent fuel pools	Variety of attacks for those pools outside secondary containment	In case of a fire, catastrophic radioactivity releases, larger than Chernobyl for long-lived radionuclides. Massive, long-term economic losses and environmental damage.	
Pebble Bed Modular Reactors	Variety of attacks, reactors proposed without secondary containment	Fires of the graphite coated fuel would disperse radioactivity over wide regions. Massive, long-term economic losses and environmental damage	Reactor in development stage. Not licensed as yet.
Advanced sodium cooled reactor	Vulnerability will depend on exact design of containment	Sodium fires or explosions as well as loss of coolant accidents could cause catastrophic dispersal of radioactivity. Higher proliferation vulnerabilities and potential for higher plutonium dispersal in accidents or attacks.	Prototype Reactor type was cancelled in 1994 but may be re-instituted by Bush plan.
Plutonium separation, all types	Proliferation	Spread of nuclear weapons usable materials and possibly of nuclear weapons including to non-state groups	Even impure separated plutonium can be used to make nuclear weapons.
Plutonium separation, current technology	Variety of attacks, depending on nature of processing and waste facilities	Wide, catastrophic dispersal of highly radioactive waste in air and water, dispersal of plutonium, diversion of plutonium	Explosion in 1957 of high-level waste tank in Soviet Union resulted in catastrophic radioactivity dispersal.
Plutonium use or storage	Vulnerability varies by location	Potential severe dispersal of large amounts of plutonium. Potential for diversion of plutonium for weapons purposes	Vulnerability increases if plutonium used as a fuel and decreases if plutonium is immobilized and stored in subsurface facilities.

Note: We have not addressed Central Asian security vulnerabilities in detail in the report due to the very fluid nature of the situation in the area, the evolving nature of the U.S.-Russian relationship, and the uncertainty about the future of oil politics in the region. But the potential for serious problems exists, especially if the area becomes a focus for regional and global economic competition.

in preliminary form earlier than planned in order to contribute to the national and international debate on energy and security that is now taking place. The report is summarized here. References can be found in the report, which is available in its entirety online at www.ieer.org/reports/energy/bushtoc.html.

Vulnerabilities

Vulnerabilities to the U.S. energy system, especially those related to oil imports and nuclear power, are greater today than ever. Table 1 summarizes oil and nuclear vulnerabilities and their potential severity.

The Bush Energy Plan

In May 2001, a task force published a National Energy Policy report, which has become the energy blueprint of the Bush administration (1). To date, the basic stance of the administration remains unchanged.

By far the most severe vulnerabilities in the Bush plan relate to oil imports and to various aspects of the nuclear power enterprise. The nuclear vulnerabilities will, in many ways, be the most severe with the Bush plan (2).

The Bush plan contains major proposals for new nuclear facilities that, if implemented, would greatly increase nuclear vulnerabilities, in addition to those associated with the prolongation of the licenses of existing nuclear power plants. The plan would result in a need to store spent fuel in pools for the indefinite future.

A change to Pebble Bed Modular Reactors (PBMRs), which do not require spent fuel pools, would mean the widespread adoption of reactors that are proposed to be built without secondary containment, making them far more vulnerable to attack than present light water reactors. Consequences of an attack on new advanced reactors like those implicit in the Bush plan could be even more catastrophic than with current commercial reactors.

The Bush energy plan would create a national electricity grid to facilitate the transmission of electricity by large-scale generators. It has been presented as part of plan to increase electricity system reliability by allowing generators to build plants anywhere they want. However, this will not necessarily address reliability problems and may aggravate them.

Vulnerabilities to the U.S. energy system, especially those related to oil imports and nuclear power, are greater today than ever.

The administration also is continuing with a plan to develop commercial plutonium fuel as a normal part of the U.S. nuclear power system. This would exacerbate both proliferation pressures and vulnerabilities to attack. It would also reverse a quarter century of bipartisan nuclear non-proliferation policy though five previous administrations.

The IEER Energy Plan

The IEER energy plan is explicitly designed to address certain security vulnerabilities that have been revealed as far more serious than generally recognized prior to September 11.

IEER's energy plan uses the same economic and demographic parameters as the Bush plan. Only the ways in which the energy services are provided for the economy are different. That is, the IEER plan assumes for instance the same number of car miles and degree of lighting or heating or cooling, but the energy system that provides these services would be structured differently.

This approach allows a direct comparison of the vulnerabilities of the two plans given the same overall economic outcomes. This approach also has some defects, which we do not attempt to remedy in the report. For instance, it does not allow the factoring in of major economic initiatives to change the underlying structure of entire energy using systems, such as the transportation system, a system in which huge investments of time, energy, money, land, and ecosystem integrity are put into a car-centered transportation system.

It also does not discuss lifestyle changes, nor the desirability of integrating the notion of "enough" at some level of consumption into the global social and economic framework.

The technological and policy-related assumptions of IEER's energy plan are described in the box below, providing the plan's framework as well as a basis from which we can compare it to the Bush plan.

IEER Energy Plan: Assumptions

1. Local electricity generation through high efficiency use of natural gas along with cogeneration of heat will be the basic approach enabling the creation of a distributed grid as well as an increase in efficiency of heating and cooling. A 60 percent electricity generation efficiency is assumed. This can be achieved with fuel cells today (though not on very small scales at present) and with advanced combined cycle natural gas fired power plants.

2. Large scale wind energy generation, notably in Midwestern states, will be the mainstay of wind energy supply. A relatively small role is assumed for solar energy.

3. Coal consumption is only marginally reduced for the first decade, then reduced to 45 percent of the year 2000 level by 2030 and then reduced to ten percent of current levels by the year 2040. Natural gas would be the main fossil fuel used in centralized electricity generation, with combined cycle plants of 60 percent efficiency. Fifty percent efficiency is the norm for such plants today and 60 percent efficient plants

are anticipated to be the norm in the near future. The large reduction of the use of coal provides a corresponding reduction in carbon dioxide emissions. A significant use of coal for three decades will allow time for transition in a vital industry and also provide for flexibility in the energy system that will provide for additional security. For instance, a decision to phase out nuclear power plants faster for security reasons would be more feasible if a coal industry is maintained at a substantial level until all nuclear power plants are closed. The maintenance of a coal industry at the 50 to 100 million tons per year would provide for flexibility in the energy system, for instance, in preventing exclusive reliance on natural gas as an interim fuel during the transition to renewables.

4. The reference technology for space heating and cooling and water heating is the geothermal heat pump, which would be used in conjunction with high efficiency local electricity generation with heat recovery. (The use of a reference technology does not imply a universal adoption of that technology but rather indicates the average efficiency that can be expected to be achieved by a variety of methods.) The fuel-based coefficient of performance for heating would average 2.4 for heating and 3 for cooling. Geothermal heat pumps are commercially available today and have been used in recent years, including by the government, for energy efficiency improvements. President Bush's ranch in Crawford, Texas is equipped with such a device.

5. Average fuel efficiency of all new passenger vehicles will be 100 mpg (42.5 km/l) by the year 2020 and the average for the whole fleet will be 100 mpg by 2030, improving 2 percent per year after that for 10 years. A government regulation to that effect will be needed in the near future if this is to be realized.

6. Aircraft efficiency will improve by 2 percent per year over the whole period in terms of fuel per seat mile.

7. Cargo transport efficiency will improve by about 3 percent per year. This will probably require efficiency standards for truck transport.

8. A carbon dioxide emissions decline of at least 40 percent and preferably 50 percent by 2040 should be achieved and made compatible with other security goals.

9. Nuclear power will be phased out by 2030.

10. Local solar, hydropower, and some cogeneration plants are largely managed for peaking power provision. Inefficient gas turbine units now widely used for providing peaking power would be phased out by 2040.

11. About 40 percent of the hydropower capacity will be dismantled by the year 2040 for a combination of security and environmental reasons.

12. A 40 percent improvement in efficiency of electricity use in non-HVAC (heating, ventilation, air conditioning) sectors is possible relative to the Bush administration's supply side plan, through government procurement policies, appropriate regulations for new developments, appliance standards, and the general use of high efficiency lighting and motors.

13. Industrial heat requirements will be met by cogeneration systems wherever possible.

14. Only those technologies that have already been tried and tested will be in widespread use enough to greatly affect energy efficiency and the energy production structure in the next two to four decades.

Findings

We assessed the IEER and Bush energy plans according to the energy system vulnerabilities discussed. Table 2 (see next page) provides a static comparison of the projected vulnerabilities of each plan in the year 2040 (3).

Conclusion and recommendations

It is stunning that the Bush administration has not revisited its energy plan proposed four months prior to September 11 in light of the events of that day. The scale of the events and the vastness of the economic impact makes it imperative that the United States take urgent and tough action to reduce energy system vulnerabilities, notably those related to oil imports, nuclear power plants and associated infrastructure, and the electricity grid. IEER's recommendations for doing so are summarized here; the full list of recommendations may be found on the web site www.ieer.org/reports/energy/bushtoc.html

Roadmap for Action**;** Recommendations from Securing the Energy Future of the United States

Main recommendations

The five most important recommendations of the IEER report, *Securing the Energy Future of the United States*, are:

- The United States should adopt an energy plan that would set goals for the long-term – a four-decade period. During this period, it must seek to essentially eliminate the most severe vulnerabilities to attack and reduce carbon dioxide emissions by about one-half by 2040.
- A goal of an average efficiency of 100 miles per gallon (42.5 kilometers per liter) for new passenger vehicles (including light trucks) should be set for the year 2020.
- A national policy decision should be made to create regional distributed electricity grids in the next three to four decades.
- Nuclear power should be phased out.
- The U.S. government should commit about US$10 billion per year to purchase renewable energy, fuel cells, efficient automobiles, efficient on-site electricity generation, highly efficient heating and air-conditioning technology, and other leading edge

Table 2: Comparison of Certain Energy System Vulnerabilities in the Bush and IEER Energy Plans, Year 2040

Vulnerability element	BUSH PLAN		IEER PLAN		Comments
	Quantitative measure	Degree of vulnerability	Quantitative measure	Degree of vulnerability	
Oil imports[a]	23 million barrels per day	Very high risk of disruption	6 million barrels per day	Low risk	Bush plan: high Persian Gulf imports.
Strategic Petroleum Reserve	700 million barrels, or about one month of imports	Moderate buffer in case of disruption	700 million barrels, or almost 4 months of imports	Substantial buffer in case of disruption	Additional supplies can be procured from alternative sources in weeks to months, if physically available.
Nuclear power reactors, LWRs	About 200 operating reactors	Powerful, September 11-scale attack would create catastrophic consequences	Zero nuclear power reactors	None	Chernobyl-scale radioactivity dispersal possible. Risk of large-scale disruption increased due to pressures to abandon nuclear power suddenly in the aftermath of an attack.
LEU spent fuel stored in pools[b]	About 20,000 metric tons in spent fuel pools	Catastrophic consequences possible from a variety of attacks	Zero	None	Long-lived radionuclide releases could be larger than Chernobyl in case of fires.
Plutonium storage[c]	Amount at high risk cannot be projected - highly policy dependent	Risk of catastrophic consequences in case of plutonium fuel diversion, accident or attack	All surplus plutonium (50 metric tons or more) immobilized in subsurface storage	Low risk of catastrophic consequences, serious local environmental results in case of attack	Bush plan reprocessing, breeder reactor, and plutonium fuel policy evolution over the decades is unclear, making quantitative projection speculative.
Electricity power stations (non-nuclear)	300 megawatt projected unit size poses lower risks than typical present generator size	Low to moderate risk of major disruption from single attack	Lower than Bush plan due to greater reliance on wind energy and dispersed generation	Low risk of major disruption	Dual fuel capability at some key plants would reduce security vulnerability.[d]
Electricity transmission	Dependent on specific system characteristics	Higher risk than at present due to further grid centralization and deregulation. Higher attractiveness as a target due to greater centralization and damage potential.	Two-fifths distributed generation	Some vulnerability from attacks on the grid will remain. Much lower attractiveness as a target compared to present.	Larger scale introduction of solar energy, locally generated hydrogen energy resources in the distributed grid system, as well as management of reserve capacity to provide quick response to disruption could nearly eliminate large-scale vulnerability.

Table notes:

a) Our main criterion for petroleum related vulnerabilities is oil imports, with high vulnerabilities being defined as sustained imports over 10 million barrels a day and very high vulnerabilities as those over 15 million barrels a day. U.S. oil imports of less than five million barrels a day would essentially eliminate the potential for catastrophic disruption, particularly if it were accompanied by a decline in European imports as well.

b) Amount of spent fuel stored in spent fuel pools assumes that an average of five years worth of discharged fuel will be in pools. The rest is assumed to be put into dry subsurface storage. This row refers to spent fuel resulting from the use of low enriched uranium (LEU) fresh fuel. The spent fuel typically contains just under one percent plutonium. We assume that all spent fuel that is more than five years old is stored subsurface to minimize the consequences of an attack.

c) Plutonium storage vulnerabilities in the Bush plan would derive from surplus military plutonium use in the commercial sector as well as possible development of commercial plutonium use. We cannot at present quantify what role plutonium may have in the energy system in the year 2040. This is because at present the only specific plutonium fuel plan relates to surplus weapons plutonium, which would presumably have passed through the reactor by then and stored as spent fuel. There is the non-quantifiable vulnerability in the Bush plan that by pursuing plutonium fuel, the United States will encourage other countries to do so. The United States is also obligated, under Article IV of the Nuclear Non-Proliferation Treaty (NPT) to provide commercial nuclear technology to non-nuclear weapons states that are parties to the treaty.

d) Dual fuel capability not explicitly factored into the IEER plan. See Lovins and Lovins, Brittle Power (1982) for a discussion of this topic.

technologies that are not fully commercial in order to promote their commercialization. Another US$10 billion per year should be given to state and local governments for the same purposes.

Notes:
(1) Bush Energy Plan 2001. This was called the Cheney Plan at the time it was issued as a recommendation to President Bush. The Bush administration has since adopted this report as the basis of its energy policy. IEER's critique of the plan was published in Science for Democratic Action vol. 9 no. 4 (August 2001) and is online at www.ieer.org/sdafiles/vol_9/9-4/cheney.html.
(2) The May 2001 National Energy Policy does not make detailed projections, such as estimated levels of oil imports or types of power plants. It makes some projections to the year 2020. IEER has estimated details to the year 2040 from the projections provided in the Bush energy plan and from official data posted on the web site of the Energy Information Administration.
(3) The time horizon we chose is approximately 40 years because it will take time to eliminate or greatly reduce some of the vulnerabilities. Because the Bush administration has not projected out the implications of its energy plan over four decades, we have done so. Assumptions we used are detailed in the report. In the IEER plan, the numbers for the first ten years have not been worked out in detail and should be treated as notional; they will depend a great deal on how the long-term policies advocated are actually implemented and what in practice is the phasing of these policies in the first decade.

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ROYAL SOCIETY REPORT UNDERSTATES RISKS OF D.U.

With the recent publication of the second report of the Royal Society on the health hazards of depleted uranium (DU) munitions, one might ask whether there has been made any progress in solving important scientific questions on the consequences of internal contamination with depleted uranium.

(565.5389) Laka Foundation - The first report focused on the radiological consequences of DU exposure. However, it was limited to serious battlefield exposures and it only dealt with increased risks of cancer and ignored the fact that ionizing radiation can cause a whole range of illnesses. These vary from disorders of the central nerve system and cardiovascular diseases, to disorders which are connected with adverse effects on the immune system, the respiratory system, digestive system, urinary passages and problems with the reproductive system. This was undoubtedly the most serious gap in the first report.

The second report is devoted to the chemical toxicity of DU. Because of the wave of criticism in a public hearing after the publication of part I, the authors add, all in all, eight pages (in chapter 3) covering a few other radiological consequences of internal contamination with DU. The report mentions adverse effects on the immune system and chromosome aberrations. However, these were mainly calculated using models based on high dose exposure. The authors didn't make use of existing literature on internal contamination with low dose radiation.

Another remarkable act in this chapter is the comparison between worst-case models of the chemical toxicity and radiotoxicity of depleted uranium oxides. This was described as if there were no interaction between these two effects within the human body. This alone raises doubts about the future research recommended by the Royal Society, especially since the possibility of synergistic interaction between chemical toxicity and radiotoxicity is not mentioned in the report.

The May 2001 report concluded that troops in a tank who survived being hit by a DU shell could double their risk of dying from lung cancer. Now the society's team of 11 experts concludes that troops in tanks that were hit (who in any case have little chance of survival) or who spend time cleaning them up could suffer heavy metal poisoning, but most soldiers would not take in enough DU to damage their kidneys.
The uranium oxide dust particles to which veterans and civilians are exposed consist of a mixture of uranium oxides with different physical and biochemical properties. All of them are chemically toxic as well as radioactive. Based on the current models, scientists often make a division between the soluble and insoluble uranium oxides. Most of the soluble oxides leave the human body very soon, but could pose an acute threat to the body. Insoluble oxides could pose chronic health effects when those particles are inhaled. The soluble oxides are connected with acute chemical poisoning with the kidney as the main target organ and the insoluble oxides are connected with chronic radiological poisoning with the lung as the potential target organ.

However, this distinction is an artificial one, because kidney cancer has also been seen in Gulf War veterans, as Malcolm Hooper, a medical chemist from the University of Sunderland who advises the British Gulf War veterans, has pointed out. He has been told that three out of the 3000 veterans so far assessed by the UK government's program have kidney cancer. This is 12 times the rate amongst civilians

and indicates that the radiation emitted by DU is causing problems as well as its chemical toxicity. "This [report] is an attempt to give a scientific imprimatur to the stance of the government, which is unacceptable," Hooper argues.

Sources: The Royal Society, The health hazards of depleted uranium (part I and II) (see http://www.royalsoc.ac.uk/policy/du.htm), NewScientist.com, 12 March 02

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IN BRIEF

Senate approves Price-Anderson. The U.S. Senate voted on 7 March to approve an amendment to the Senate Energy Bill extending the Price-Anderson Act for another 10 years. Price-Anderson is the 1957 law that allows the commercial nuclear industry to operate with a cap on their liability for a catastrophic accident (see NIRS *Nuclear Monitor*, December 2001). The amendment contains a clause allowing modular reactor (PBMR) licensees to insure many reactors on one site as if they were just one reactor. This effectively gives a subsidy to PBMRs even though they lack a containment and so are particularly vulnerable to terrorist attacks. The Senate Energy Bill also funds nuclear research and development, while repealing legislation allowing small energy producers to sell energy into the electrical grid - a move which could severely damage renewable energy producers.
NIRS Alert, 11 March 2002

Notorious Sellafield plant to re-start; Irish protest. The Sellafield MOX Demonstration Facility, notorious for the 1999 MOX falsification scandal (see *WISE News Communique* 518.5083, "BNFL fiddling MOX quality control data") has been given permission to re-start. BNFL say the plant will carry out support trials for the larger Sellafield MOX Plant. The U.S. government has approved plans to return a shipment of the falsified MOX from Japan to Sellafield. U.S. permission for the shipment was required in line with a U.S.-Japan bilateral agreement on nuclear energy. The Irish campaign against Sellafield continues. A demonstration was held in Dublin on 9 March, and plans are afoot to send nearly 1½ million protest postcards to Tony Blair, Prince Charles and BNFL chief executive Norman Askew.
***Whitehaven News*, 14 March 2002; *WNA News Briefing*, 6-12 March 2002; uk.indymedia.org; Reuters, 18 March 2002**

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WISE/NIRS NUCLEAR MONITOR

The Nuclear Information & Resource Service was founded in 1978 and is based in Washington, US. The World Information Service on Energy was set up in the same year and houses in Amsterdam, Netherlands. NIRS and WISE Amsterdam joined forces in 2000, creating a worldwide network of information and resource centers for citizens and environmental organizations concerned about nuclear power, radioactive waste, radiation, and sustainable energy issues.

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and Jeff Newman, of Long Island.
Both were key activists-
we suffer a great loss with their
passing.

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